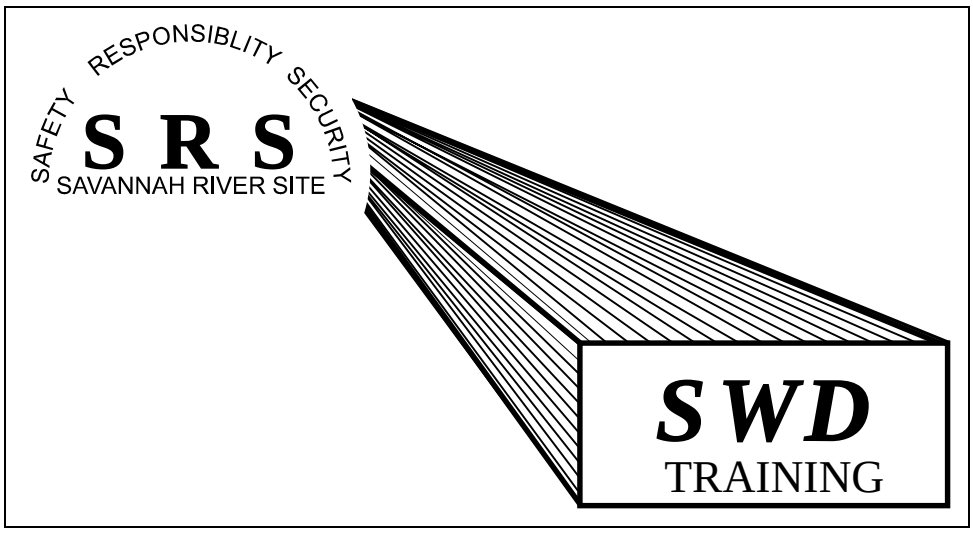
Consolidated Incineration Facility
Operator Training Program
Caustic Unloading System

STUDENT STUDY GUIDE



Reviewed By:_____ _____
Engineering Date

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Training Manager Date

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REVISION LOG

REV.	AFFECTED SECTION(S)	SUMMARY OF CHANGE
00	All	Initial issue. Course material extracted from the Offgas System material.

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LIST OF FIGURES

REFERENCES

1. 261-SOP-CAUS-01, *Caustic (U),* Rev. 02

2. J-SD-H-00003, *Functional Description, Offgas System* (DA H265)

3. W830325, *Savannah River Site Building 261-H Area 200-H Caustic Storage Tank Process Service PPG & Instrument Diagram Process & Instruments (U),* Rev. 27

4. W833059, *Savannah River Site Bldg. 262-H, Area 200H Consolidated Incineration Facility Tank Farm Motor Schematics Sheet 7 Electrical,* Rev. 03

5. W835649, *Savannah River Site Bldg. 261-H, Area 200H Consolidated Incineration Facility. Fuel Oil & Caustic Unloading Process Service PPG & Instrument Diagram Process & Instruments (U),* Rev 30

LEARNING OBJECTIVES

TERMINAL OBJECTIVE

1.00 Without references, **EXPLAIN** the significance of the Caustic Unloading System to Consolidated Incinerator Facility operations, including its importance to safety, and the impact on operations of a failure of the system.

ENABLING LEARNING OBJECTIVES

1.01 **STATE** the purpose of the Caustic Unloading System.

1.02 Briefly **DESCRIBE** how the Caustic Unloading System accomplishes its intended purpose.

1.03 **EXPLAIN** the consequences of a failure of the Caustic Unloading System to fulfill its intended purpose, including the effects on other systems or components, overall plant operation, and safety.

LEARNING OBJECTIVES (CONT.)

TERMINAL OBJECTIVE

2.00 Using system diagrams, **EVALUATE** potential problems that could interfere with normal Caustic Unloading System flowpaths to determine their significance on overall system operation and the corrective actions needed to return the system to normal.

ENABLING LEARNING OBJECTIVES

2.01 **DESCRIBE** the physical layout of the Caustic Unloading System components including the general location, quantities, and functional relationship for each of the following major components:

a. Pumps

b. Tanks

2.02 **DESCRIBE** the Caustic Unloading System arrangement to include a drawing showing the following system components and interfaces with other systems:

a. Caustic unloading pump

b. Magnetic flowmeters

c. Caustic Storage Tank

LEARNING OBJECTIVES (CONT.)

TERMINAL OBJECTIVE

3.00 Given values of Caustic Unloading System operation parameters, **EVALUATE** potential problems that could effect the normal functioning of the system or its components to determine the significance of the existing condition and the actions required to return the system to normal operation.

ENABLING LEARNING OBJECTIVES

3.01 **DESCRIBE** the following major components of the Caustic Unloading System including their functions, principles of operation, and basic construction:

a. Caustic unloading pump

b. Caustic Storage Tank

3.02 **STATE** the design capacities and operational limitations for the following Caustic Unloading System major components:

a. Caustic transfer pump

b. Caustic storage tank

3.03 Given values for key performance indicators, **DETERMINE** if Caustic Unloading System components are functioning as expected.

3.04 **DESCRIBE** the following Caustic Unloading System instrumentation, including indicator location (local or Control Room) sensing points and associated instrument controls.

a. Caustic and process water flows

b. Caustic storage tank temperature

c. Caustic storage tank level

3.05 **INTERPRET** the following Caustic Unloading System alarms, including the conditions causing alarm actuation and the basis for the alarms:

a. Caustic storage tank level

b. Caustic storage tank temperature

LEARNING OBJECTIVES (CONT.)

3.06 **EXPLAIN** how the Caustic Unloading System unloading pump is controlled in all operating modes or conditions to include: control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation.

3.07 **DESCRIBE** the interlocks associated with the following Caustic Unloading System pumps to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary.

LEARNING OBJECTIVES (CONT.)

TERMINAL OBJECTIVE

4.00 Given necessary procedures or other technical documents and system conditions, **DETERMINE** the operator actions required for normal and off normal operation of the Caustic Unloading System including problem recognition and resolution.

ENABLING LEARNING OBJECTIVES

4.01 **STATE** the personnel safety concerns associated with the Caustic Unloading System.

4.02 Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Caustic Unloading System operations:

a. Receiving and unloading caustic
b. Flushing Caustic System piping

4.03 **DETERMINE** the effects on the Caustic Unloading System and the integrated plant response when given any of the following:

a. Indications/alarms
b. Malfunctions/failure of components
c. Operator Actions

SYSTEM PURPOSE

Introduction

The incineration of waste materials, regardless of the types, requires the use of air pollution control devices or offgas treatment. The ability to properly clean offgas of potentially harmful contaminants, prior to release to the atmosphere, is legally required and necessary to protect health and the environment, and gain public acceptance.

Low-level radioactive, hazardous, and mixed solid and liquid wastes are shipped to CIF for incineration. These wastes are incinerated at temperatures and with sufficient residence time to achieve the desired 99.99% Destruction and Removal Efficiency (DRE). Combustion takes place when fuel oil and air are mixed in suitable ratios at a high enough temperature to ignite the mixture. Combustion needs to be complete to minimize the amount of material contained in the Offgas System. Fuel consisting of organic compounds contains large amounts of carbon and hydrogen. Other elements such as sulfur, chlorine, oxygen, metals, and inorganic compounds are present in the fuel and contribute to ash and offgas constituents. These products are important from the standpoint of pollution control. In an efficiently operated incinerator, most of the organic compounds experience complete combustion. The carbon (C) oxidizes to form carbon dioxide (CO_2); hydrogen (H) oxidizes to form water (H_2O).

Combustion of organic chlorides such as polyvinylchlorides (PVCs) will result in the formation of hydrogen chloride (HCl). HCl formation is the primary reason for the offgas becoming acidic in nature.

Nitrogen oxides (NO_x) are also a component of the offgas. The amount of NO_x produced is a function of temperature, excess air, and fuel composition. The greater the amounts of excess air, the greater the amount of nitrogen present, thus higher quantities of NO_x can be expected.

Sulfur oxides (SO_x) emissions are primarily in the form of sulfur dioxide (SO_2) and are directly related to the amount of sulfur in the waste stream. Like HCl, NO_x and SO_x cause the offgas to become acidic. Because the offgas is acidic, the Offgas System is equipped with a Caustic Treatment System to neutralize acids. The Caustic Treatment System must be supplied with a source of sodium hydroxide (NaOH, or caustic) solution.

Purpose

1.01	**STATE** the purpose of the Caustic Unloading System.
1.02	Briefly **DESCRIBE** how the Caustic Unloading System accomplishes its intended purpose.
1.03	**EXPLAIN** the consequences of a failure of the Caustic Unloading System to fulfill its intended purpose, including the effects on other systems or components, overall plant operation, and safety.

The purpose of the Caustic Unloading System is to unload caustic solution from tanker trucks and store the caustic for use in the Caustic Treatment System. The system performs this function through the use of an unloading pump, a mixing system, and a storage tank.

Since the Offgas System needs a constant supply of caustic during operation, failure of the Caustic Unloading System or Treatment System could result in the shutting down of CIF in order to prevent exceeding regulatory requirements. The system can store a 12-day supply of caustic based on an average process use rate of 19 gallons per hour.

MAJOR FLOWPATHS

Caustic Unloading System Flowpath

2.01	**DESCRIBE** the physical layout of the Caustic Unloading System components including the general location, quantities, and functional relationship for each of the following major components: a. Pumps b. Tanks
2.02	**DESCRIBE** the Caustic Unloading System arrangement to include a drawing showing the following system components and interfaces with other systems: a. Caustic unloading pump b. Magnetic flowmeters c. Caustic Storage Tank

The Caustic Unloading System consists of two flow meters, a control valve, a process water control valve, a mixing valve, an unloading pump, and a storage tank as shown in Figure 1 - Caustic Unloading System.

Caustic unloading from a tanker truck replenishes the caustic storage tank. Caustic is normally delivered in a 20% concentration, the concentration required in the Offgas System. If a 20% solution is delivered, the process water valve and mixing tee are not used. Caustic is pumped straight from the tanker to the storage tank using the caustic transfer pump.

If a 50% solution is delivered, the caustic is diluted with process water prior to entering the storage tank. The process water is mixed with the caustic at the suction of the caustic unloading pump. The mixing process involves flow measurement and control of the process water, as well as flow measurement of the caustic. Controlling the amount of process water mixed with the caustic controls the caustic dilution. The operator entering the dilution set point into the ratio controller controls the dilution. A flow meter installed in each line provides input to the ratio controller which in turn positions the process water flow control valve.

Flow from each line combines in a mixing valve and then enters the unloading pump for discharge to the storage tank. Three caustic pumps draw a suction on the storage tank.

The caustic unloading pump and the mixing valve are located at the Clean Unloading Facility (Figure 2 - Tank Farm Layout). The caustic storage tank is located at the Offgas Tank Area (Figure 3 - Offgas Tank Area).

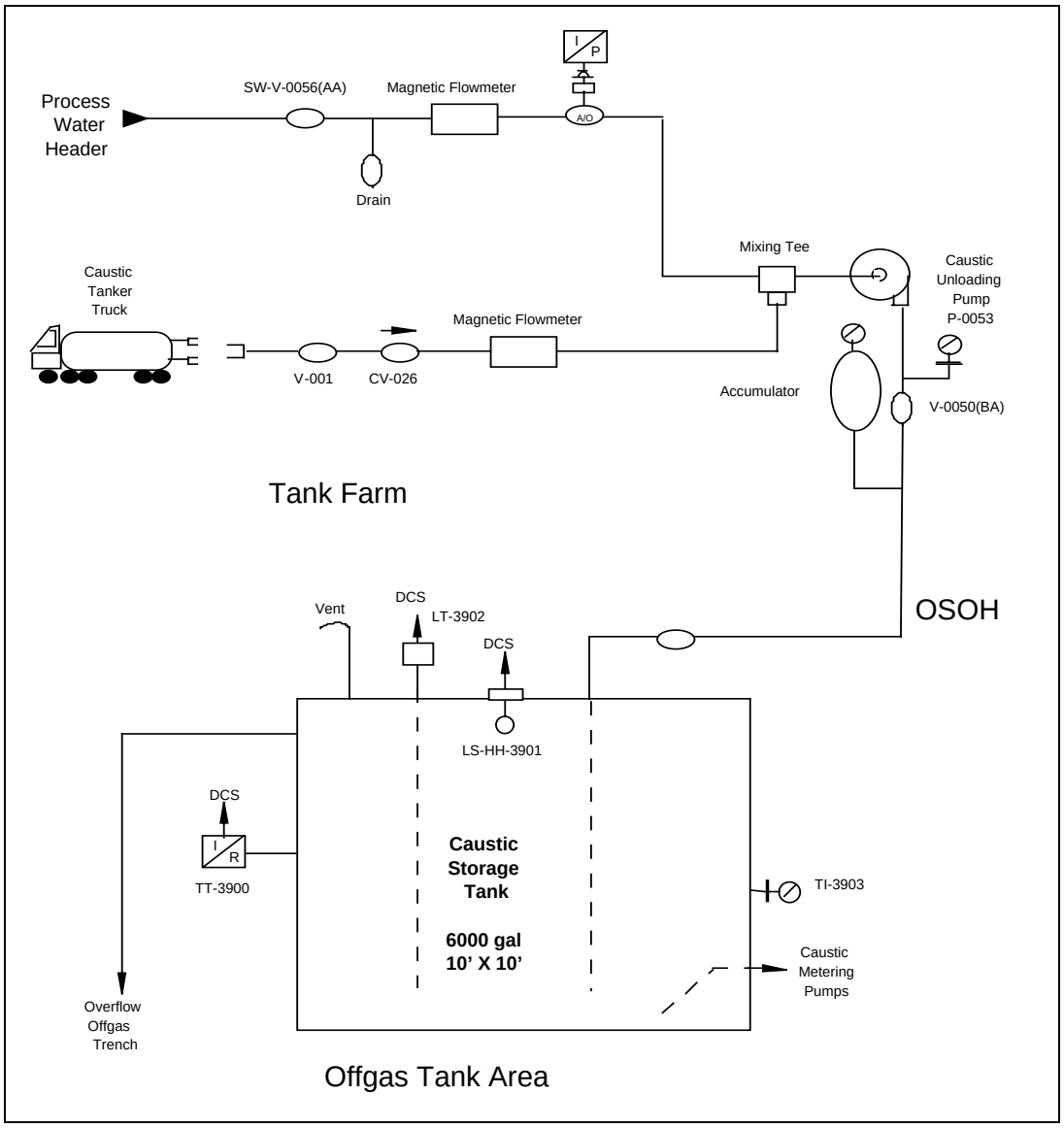

Figure 1 - Caustic Unloading System

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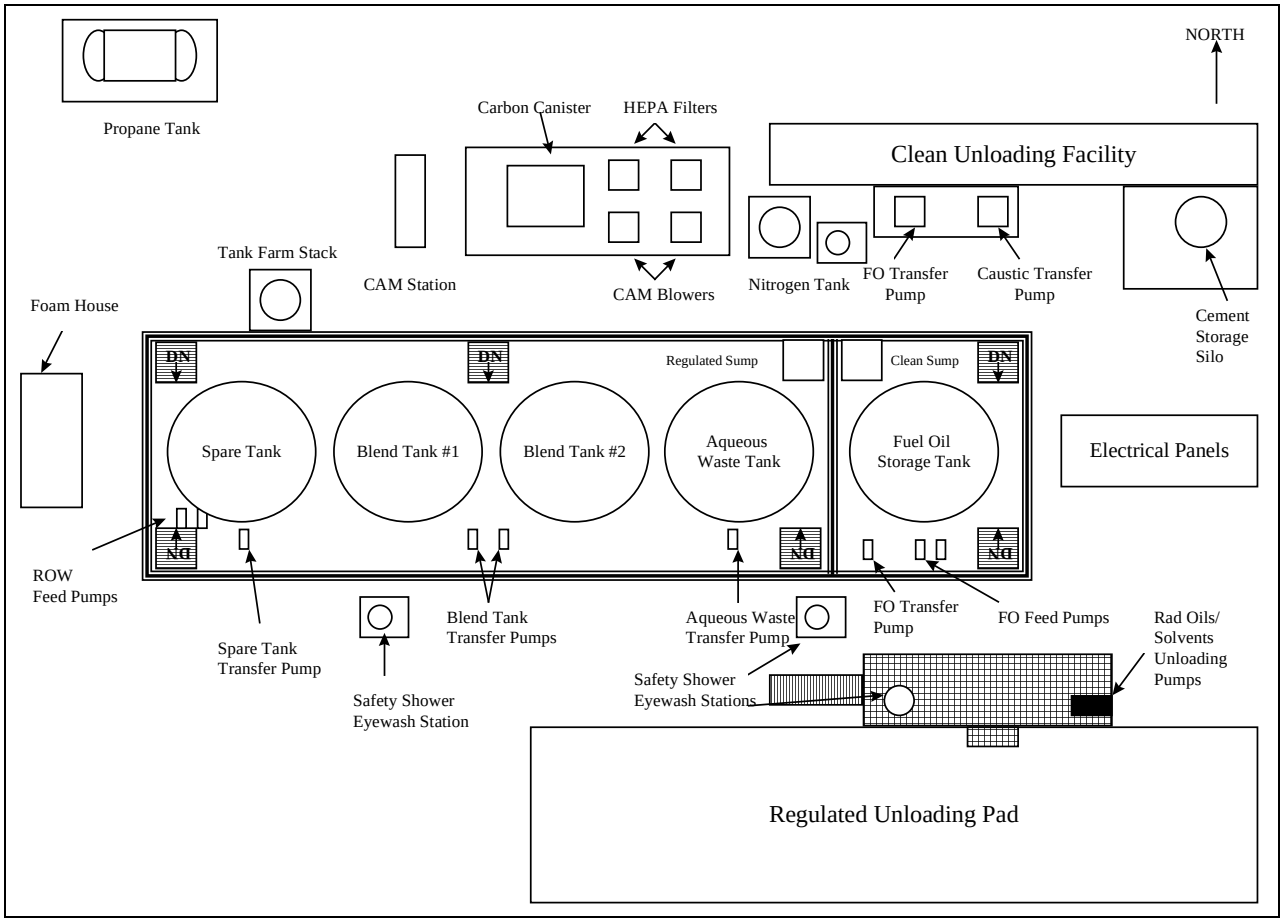

Figure 2 - Tank Farm Layout

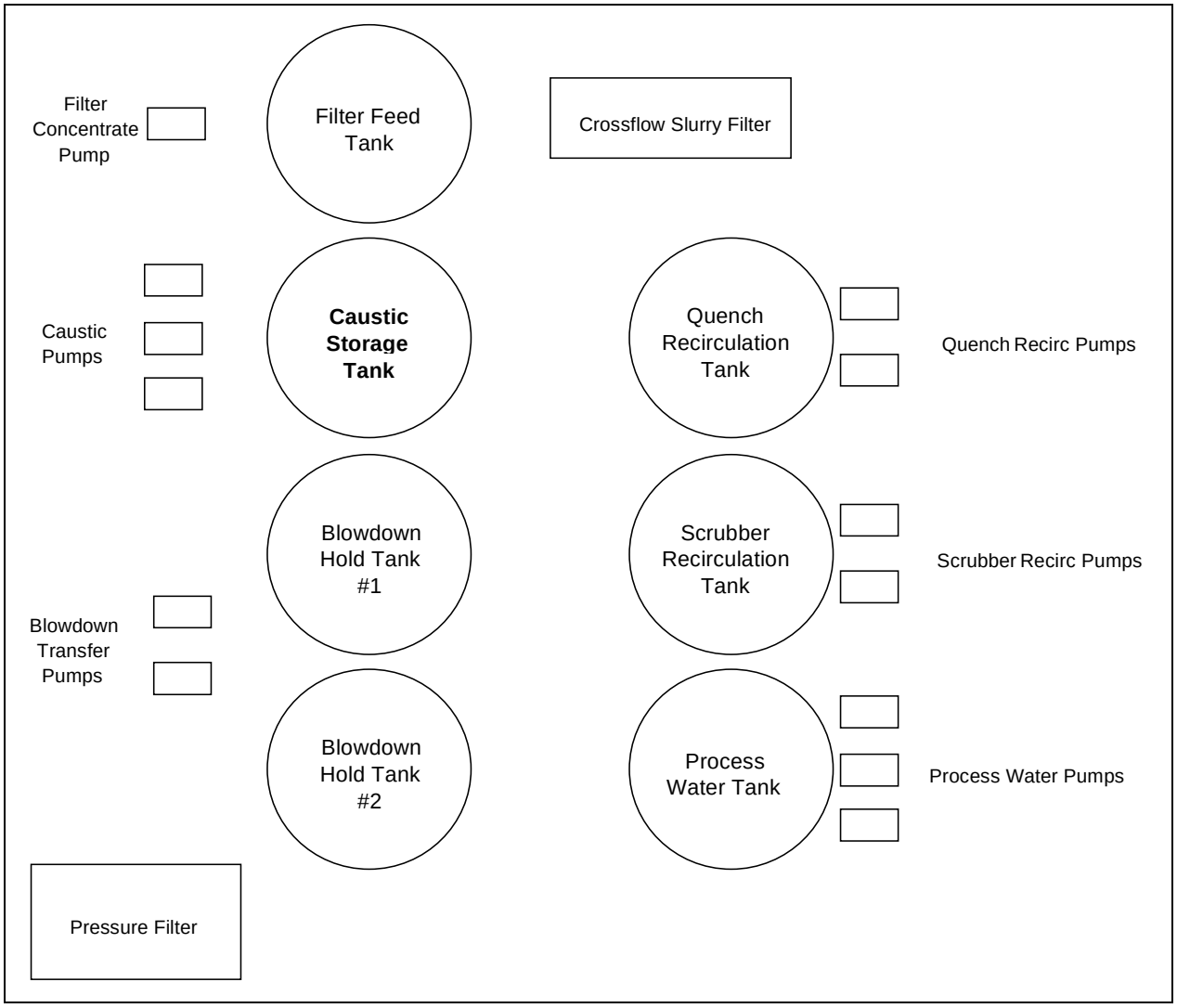

Figure 3 - Offgas Tank Area

MAJOR COMPONENTS

Caustic Unloading Pump (H-262-CAUS-P-0053)

3.01	**DESCRIBE** the following major components of the Caustic Unloading System including their functions, principles of operation, and basic construction: a. Caustic unloading pump b. Caustic Storage Tank
3.02	**STATE** the design capacities and operational limitations for the following Caustic Unloading System major components: a. Caustic transfer pump b. Caustic storage tank

The caustic unloading pump is a horizontal, centrifugal pump, located at the Clean Unloading Facility. It provides 50 gpm at 92 ft TDH with an explosion proof 5 HP motor, powered from MCC-3. The shell is cast iron. At operating rate it takes about two hours to unload a delivery vehicle. See Figure 1 - Caustic Unloading System. The pump is started using the local start pushbutton, and is normally stopped using the DCS.

Mixing Tee (H-262-MIX-0053)

The purpose of the mixing tee is to mix the incoming caustic with process water to provide the desired 20% caustic solution. It is located near the caustic unloading pump. Some shipments of caustic solution are at 50%. During the unloading of these shipments, process water will be added to the mixing tee, along with the caustic solution.

Process Water Control Valve (H-262-SW-FCV-0056)

The process water control valve automatically adjusts process water flow in order to obtain a 20% caustic solution while unloading 50% caustic. It is a 1-inch, pneumatically-operated globe valve controlled from the DCS. When caustic is unloaded, a dilution ratio is entered into the DCS (the ratio is 2.3). The DCS will then monitor process water and caustic flows to maintain this ratio. This will ensure that the caustic solution being fed to the caustic storage tank is 20%.

If the caustic delivery is already at 20%, the valve will be placed in “MAN.” This will close the valve so that no process water is added.

Caustic Storage Tank (H-261-CAUS-TK-001)

The Caustic Storage Tank (Figure 1 - Caustic Unloading System) is a 6000 gallon tank, welded

carbon steel vessel with a diameter of 10 feet and a height of 10 ft. The working volume of the tank is 5500 gallons that provides a 12 day supply of caustic based on a process use rate of 19 gallons per hour. Tank pressure protection is provided by a vent to atmosphere and an overflow that drains to the Offgas Trench.

INSTRUMENTATION AND CONTROLS

Caustic and Process Water Flows

3.03	Given values for key performance indicators, **DETERMINE** if Caustic Unloading System components are functioning as expected.
3.04	**DESCRIBE** the following Caustic Unloading System instrumentation, including indicator location, (local or Control Room) sensing points, and associated instrument controls: a. Caustic and process water flows b. Caustic storage tank temperature c. Caustic storage tank level
3.05	**INTERPRET** the following Caustic Unloading System alarms, including the conditions causing alarm actuation and the basis for the alarms: a. Caustic storage tank level b. Caustic storage tank temperature
3.06	**EXPLAIN** how the Caustic Unloading System unloading pump is controlled in all operating modes or conditions to include: control locations (local or Control Room), basic operating principles of control devices, and the effects of each control on the component operation.

Two magnetic flowmeters, one located in the caustic unloading line and one located in the process water line, sense flow when unloading caustic. This information is fed to the DCS for indication. When 20% caustic is delivered, process water flow controller is placed in manual so that no process water is added, the caustic flow indication will indicate pump flow and the process water flow indication will read zero. When unloading 50% caustic, the DCS automatically maintains a ratio of 2.3 of process water to caustic in order to make the needed 20% caustic.

Caustic Storage Tank Instrumentation

The indications associated with the caustic storage tank are temperature and level. This information is provided on the DCS and is also used for interlocks.

Caustic Storage Tank Temperature (PT-CAUS3900T-1)

An RTD sensor/temperature transmitter (H-261-CAUS-TT-3900) monitors the Caustic Tank temperature. This instrument provides a signal to the DCS for indication (H-261-CAUS-TI-3900) and alarms. A high-high alarm at 100ºF and a low-low alarm at 65°F are available. High temperatures in the tank could indicate an abnormal reaction from within the tank. A low temperature can cause the caustic solution to gel, preventing the caustic metering pumps from delivering caustic to the Offgas System at the specified rate. In addition to the DCS indications, a local temperature indicator is available on the tank.

Caustic Storage Tank Level (PT-CAUS3902L-1)

A differential pressure (DP) transmitter (H-261-CAUS-LT-3902) monitors caustic storage tank level. Alarms and the associated interlocks are:

- CAUS3902LA-2 Low (28") gives alarm indications only
- CAUS3902LA-1 Low-Low (24") inhibits caustic pumps Nos. 1, 2, & 3. A low-level condition indicates that the caustic pump must be filled. Operating the caustic pumps with an inadequate amount of caustic could cause pump damage.
- CAUS3902LA Low-Low-Low (20") gives alarm indications only
- CAUS3902LA-3 High Level (102") & CAUS3901LA High-High-High Level (105") inhibit the operation of the caustic unloading pump. A high level in the tank may cause the tank to overflow. The normal maximum level allowed in the tank is 100 inches.

Caustic Unloading Pump Controls

3.07	**DESCRIBE** the interlocks associated with the following Caustic Unloading System pumps to include the interlock actuating conditions, effects of interlock actuation, and the reason the interlock is necessary**.**

The caustic unloading pumps contain a local MOA switch. When in the "MAN" position, the pump can only be operated using the local start pushbutton. The pump cannot be operated from the DCS and no interlocks will shut down the pump.

When in the "AUTO" position, the pump is started locally using the start pushbutton, and is stopped using the DCS. The pump can also be stopped by taking the local MOA switch to "OFF." When operating in "AUTO," the pumps will automatically shut down on a caustic tank high level (102") and a caustic tank high-high-high level (105"). This interlocks prevents the caustic tank from overflowing.

SYSTEMS INTERRELATIONS

Instrument Air System

Instrument air is used to operate the pneumatically controlled process water control valve (SW-LCV-0056) in the Caustic Unloading System. This valve fails closed on a loss of air.

Process Water System

Process water is supplied to the Caustic Unloading System using the process water control valve (H-261-SW-FCV-0056). This valve controls process water flow during unloading to provide the proper dilution if a 50% solution is delivered.

Offgas System

The Caustic Unloading System provides a supply of caustic solution for use in the Offgas System. The Offgas System uses the solution to neutralize acids in the offgas to correct for chemistry. If the Caustic System could not supply caustic, the incinerator would have to be shut down.

INTEGRATED PLANT OPERATIONS

Safety

4.01	**STATE** the personnel safety concerns associated with the Caustic Unloading System.

The personnel safety concerns associated with the Caustic Unloading System include hazards common to operating industrial plants and chemical hazards unique to the Consolidated Incinerator Facility (CIF) Caustic Unloading System.

The most important chemical hazard unique to the CIF Caustic Unloading process is from the use of caustic. Caustic (NaOH) solution, upon contact with eyes or skin, can cause blindness and skin burns. If any solution comes in contact with the body, the affected clothing must be removed and the area flushed with large amounts of water until emergency response personnel arrive. During unloading operations, unloading personnel must wear a face shield, eye goggles, leather and rubber gloves, and a plastic apron to minimize the chance of coming in contact with the solution.

Caustic System Operation

Operation of the Caustic System is controlled by 261-SOP-CAUS-01, *Caustic (U).* The following operations are addressed in these procedures:

- System Alignment
- Ordering Caustic
- Receiving Caustic and unloading caustic
- Flushing Caustic System Piping

4.02	Given applicable procedures and plant conditions, **DETERMINE** the actions necessary to perform the following Caustic Unloading System operations: a. Receiving and unloading caustic b. Flushing Caustic System piping
4.03	**DETERMINE** the effects on the Caustic Unloading System and the integrated plant response when given any of the following: a. Indications/alarms b. Malfunctions/failure of components c. Operator Actions

System Alignments

A system alignment is performed whenever the alignment is in doubt or if maintenance has been performed on the system. During normal operation, the latest alignment will be in the system status file, and no further alignments are necessary.

Ordering Caustic

Caustic is ordered when level in the caustic storage tank reaches 35.5 inches as indicated on the DCS. This level corresponds to approximately 1500 gallons left in the tank. To order caustic, the Shift Supervisor will call Work Control to schedule a delivery.

Receiving and Unloading Caustic

Once the delivery arrives at the CIF gate, an operator will meet the truck and ensure that the purchase order, certificate of analysis, and caustic concentration are correct. If any of these items are not correct, the Shift Supervisor will be informed in order to reject the shipment.

Prior to unloading, safety equipment will be collected, the truck will be parked at the unloading station, and the truck will be chocked with the keys removed. A "Danger-Unsafe Condition" tag will be placed on the steering wheel to prevent movement of the truck during unloading.

During cold weather, the delivery truck may need heating. Caustic solution, if allowed to cool to approximately 55-60°F, will form a gel that is not easy to pump. A solution of 20% is not a susceptible to solidification as a solution of 50%. A temporary flexible hose, connected to the 30-lb. Steam System, can provide heating to the tanker truck through a heating connection. The driver will determine if heating is necessary.

Spill kits will be stationed around the unloading area to contain a spill if one were to occur. All hoses and connections are inspected prior to connection to ensure they are in good working order to prevent leakage.

Once unloading hoses have been connected, the CRO is informed that caustic is ready to be unloaded. Valves are aligned for the unloading process.

If the solution is already 20%, the controller will be set to "MAN" so that no process water will be added to the caustic. If the solution is 50%, the CRO will set the dilution controller to 2.3 to ensure the resultant concentration is correct.

The caustic unloading pump is started locally with the MOA switch in "AUTO" using the start pushbutton. Caustic is unloaded until the caustic storage tank reaches a level of 100 inches. At that point, the CRO will stop the pump from the DCS and the local control switch will be taken to "OFF." The unloading lineup and hoses can then be secured.

Flushing Caustic Piping

Flushing of the system is sometimes necessary in order to remove unwanted material in the lines. During flushing, maintenance connects a temporary connection at the inlet piping to the unloading pump. Service water is used to flush the piping as directed by the SS. During the flush, the unloading pump is flushed to the caustic tank for a period of 5 minutes. Once the flush is complete, the temporary connections are removed.

Uses of Caustic

As mentioned previously, caustic is used in the Offgas System for the removal of acidity in the offgas. The system contains three metering pumps that pump caustic into the Offgas System at the Quench and Scrubber system recirculation lines. The pH of the system is monitored in the quench recirculation line, in the scrubber recirculation line, and in the cyclone separator drain line. The DCS automatically controls the speed of the metering pumps to control pH in these lines. For more information on the Caustic Treatment System, refer to ZIOITX17, *Offgas System.*